PowerMax+

INSTALLATION MANUAL
15kW Low-Speed

A&C GREEN ENERGY
Renewable Energy for Life

Contents

1	Statement from A&C Green Energy	4
2	Summary	5
2.1	Information	5
2.2	Mark Illustrations	5
2.3	Applications for Use	5
2.4	Structure and Main Property	6
2.5	Technical Specifications	7
2.6	Output Power and Performance Curves	7
2.7	Wind Turbine Features	8
2.7.1	Blades	8
2.7.2	Generator Body	8
2.7.3	Nacelle	8
2.7.4	Tail Furling Mechanism	8
3	Safety Rules	9
4	Preparation	9
5	Turbine Assembly	10
5.1	Tail Vain Assembly	10
5.2	Tail Beam Assembly	10
5.3	Tail Rudder Assembly	11
5.4	Nacelle Winch Assembly	11
5.5	Braking Push Rod Assembly	12
5.6	Blade Assembly	13
5.7	Tower Assembly	14
5.8	Power Cable Connection	15
6	Machine Assembly and Installation	16
6.1	Safety Not for Installation	16
6.2	Installation of Turbine Machine by Crane	16
6.3	Installation Without a Crane (Brace Strut Method)	19
7	Electric Connection	24
7.1	Off-Grid System	24
7.2	Grid-Tie System	25
8	Operation	26
8.1	Checking Before Operation	26
8.2	Checking Output Circuit Line of Generator	26
8.3	Checking Yawing Mechanism and Hydraulic Braking	26
8.4	Checking Electrical Compatibility of the Equipment	26
8.5	Trial Operation	26
8.6	Normal Operation	27
8.7	Normal Shut Down	27
9	Maintenance	29
10	Troubleshooting	31
Appendix 1	15m Freestanding Tower Foundation	33
Appendix 2	15m Lattice Tower Foundation	34
Appendix 3	15m Guyed Tower Foundation	35
Appendix 4	Packing List	36
Appendix 5	Wind-Solar-Diesel Hybrid System	37
Appendix 6	AC380V/AC220V Grid Feeding	38
Appendix 7	Bolt Torque (Nm) Sheet	38

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Prior to installation and operation, it is important that you thoroughly read this manual to ensure proper performance and safety.

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STATEMENT FROM A&C GREEN ENERGY

For contents described in this specification, A&C Green Energy can not ensure its completeness and accuracy. For the any installations which lay beyond normal installation sites, A&C Green Energy will not make any instruction or guarantee.

A&C Green Energy is not responsible for any damage and/or injury caused under the following situations:

* Damage caused by any inappropriate operation
* Damage caused by lightning, typhoon and other force majeure
* Damage occurred after the warranty has expired

Notice: All installation instructions & drawings are valid only within the warranty period.

Note: Proper installation depends on the safety precautions and attention of the installer. Please follow common sense guidelines for correct operation, technique and installation. A&C Green Energy will not be responsible for any inappropriate operation which may cause any property damage or personal injury. All risks will be assumed by the end-user and his designated installer.

Please note: the annual electricity output from the wind generator is determined by the local wind resources and other factors, such as the installation elevation of wind generator, environmental temperature, maintenance, terrain and density of periphery buildings. A&C Green Energy can not make any guarantee for the actual power output and energy generated by the wind generator.

This product specification is a general installation guide only and cannot be used as a special maintenance guide.

2. Summary

2.1 Information

We have improved this product specification, but at the same time, A&C is improving its products unremittingly. There may be some undocumented differences between the product you received and this specification.

Please use original PowerMax+ parts. Do not refit the original assembled wind generator, otherwise it may void the repair warranty.

2.2 Mark Illustrations

Within this guide, please pay close attention to the following tips and warnings:

Warning： means there are risks that may cause personal injury, or perhaps death.

Caution: means there are risks that may cause wind turbine, equipment or property damage.

Advice: helpful installation & maintenance hints from the manufacturer.

2.3 Applications for Use

- Off-grid application: The electricity generated by the wind turbine can be stored into batteries. Through an off-grid inverter, the DC can be changed into stable AC for off-grid power supply.
- On-grid application: The electricity generated by the wind turbine can be rectified into DC. Through an on-grid inverter, the DC can be converted into stable AC and feed the local utility grid.

2.4 Structure and Main Property

This turbine is composed of blades, permanent magnet generator, nacelle, tower rod, tail rudder, electric winch, dump load, electric controller, battery bank, inverter, cable, etc. (see Fig.1)

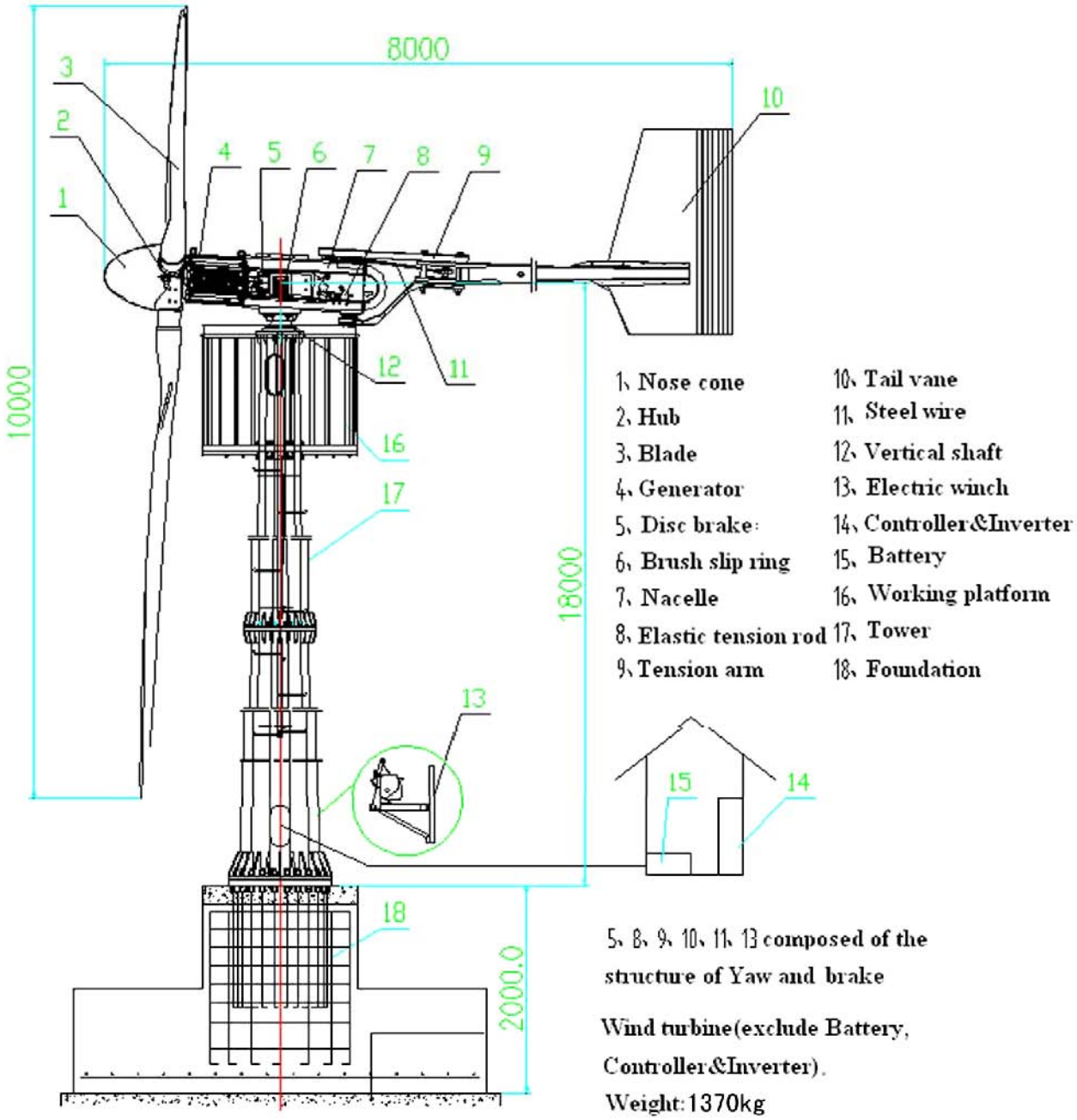


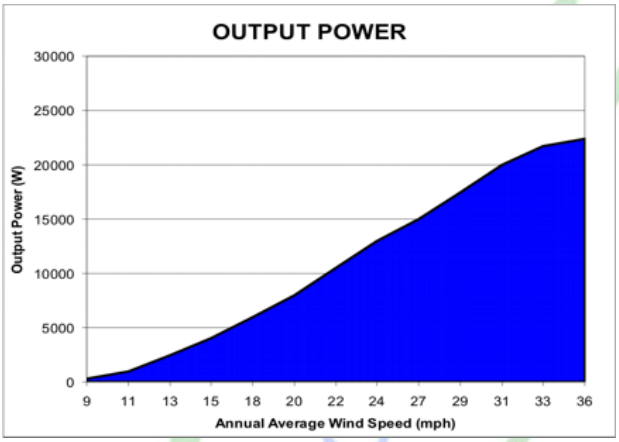
Fig.1

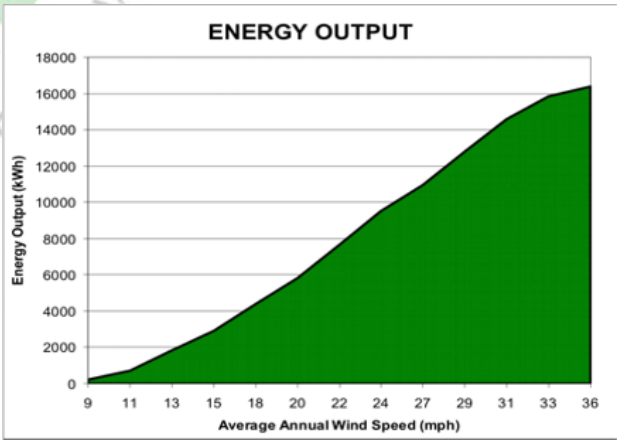
2.5 Technical Specifications

TECHNICAL SPECIFICATIONS

Blade Diameter	32.8 feet
Blades	3 Fiberglass-Reinforced Thermoplastic
Rated Power	15,000 W
Rated Wind Speed	26.8 mph
Start-up Wind speed	6.7 mph
Working Speed	9-56 mph
Survival Wind Speed	112 mph
Rated rpm	180 rpm
Working Voltage	DC500V / AC380V
Generator Type	Three-phase AC PM (permanent magnet)
Power Supply Method	3-phase, whole-wave bridge rectifier, constant DC voltage charge with output voltage of AC380V, both On-grid and Off-grid by Controller and Inverter
Speed Regulation	Yawing & Electromagnetic Brake
Shut Down Method	By Hand or Automatic
Turbine Weight	2,866 lbs
Generator Lifespan	15 years

2.6 Output Power and Performance Curves





wind speed m/s	4	5	6	7	8	9	10	11	12	13	14	15	16
mph	9	11	13	15	18	20	22	24	27	29	31	33	36
Output power W	300	1000	2500	4000	6000	8000	10500	13000	15000	17500	20000	21700	22400
output power P(kW)	0.3	1	2.5	4	6	8	10.5	13	15	17.5	20	21.7	22.4
kWh	219	730	1826	2922	4383	5844	7670	9496	10957	12783	14610	15851	16363

2.7 Wind Turbine Features

2.7.1 Blades: With high tip-speed and lift-over-drag ratios, and a noise of lower than 65db, the blades have been aerodynamically optimized for better performance. The blades have passed extensive wind tunnel tests. Made of special purpose gel-coat resin and reinforced FRP, each PowerMax+ blade set is highly durable and will guarantee safe operation under a wind speed of up to 2 times the rated wind speed. When static, it can resist a wind speed of up to 60m/s. Its wind power efficiency is higher than 0.4.

2.7.2 Generator Body: Made of strong magnet material, and a good quality shaft, the generator housing has adopted the F-grade insulation and IP54 protection, as well as a maintenance free design. All this has contributed to over a 30,000 hour lifespan. The motor shell has been aluminum coated with power generating efficiency of over 90%.

2.7.3 Nacelle: Made of a welded steel plate with high durability and strength, the nacelle surface has been galvanized to protect it under such harsh environments as humidity, sand storm, and salty mist.

2.7.4 Tail Furling Mechanism: At a wind speed of over 25m/s, the winch will automatically tighten the steel rope to adjust the tail rudder; consequently, the turbine will pivot to gradually avoid the direct wind, slowing down the inherent rotation speed. The yawing angle is adjustable: under a yawing angle of 45°～60°, the output power can be reduced to half, when the yaw angle is 80°, the brake trigger attached on the tail pin will allow the braking rod to push the braking clip atop the motor shaft to slow down the rotation. This rotational speed regulation mechanism can also be triggered by the manual winch.

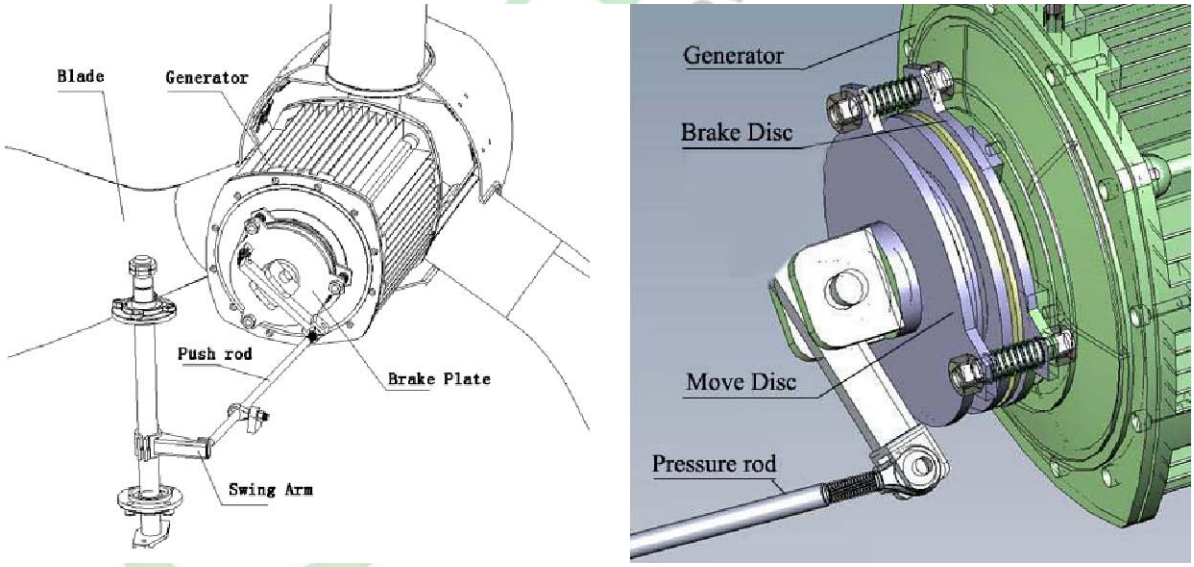


Fig 2

3. Safety Rules

- Do not allow the turbine to run without a load, or at continual high speeds.
- If applicable, check the guyed tower and guy wires regularly to ensure proper tension.
- Do not stand under a wind turbine during high winds.
- When the wind speed is over 24m/s, manually shut down the wind turbine.
- If there is an unprecedented vibration or strange noise being detected during turbine operation, stop the wind turbine for inspection.
- When wiring the wind turbine system, connect the battery bank first, then the output cable of the generator; in disassembling the turbine system, please disconnect the output cable of the generator before cutting off the battery line. （See appendix 5）
- The switch on the breaker panel should be in the "on" position. This should only be turned off when the batteries have been fully charged or to protect the system from devastating gusts. This switch should be touched only when the turbine is rotating slowly.
- The battery bank should be kept away from fire, heat, and direct sunlight. Any harmful gasses from the battery charging and discharging should be exhausted on a timely basis.
- Keep the rotor balanced to eliminate any vibration: In the case that the blades become unbalanced, the wind generator must be shut down for a check. Once the trouble has been eliminated, the unbalanced torque should be no larger than 0.02N.m.

CAUTION Do not touch the "off" switch on the breaker panel when the wind turbine is rotating fast. The electric breaker can only be turned off when the turbine is stopped or rotating slowly!

WARNING Keep the battery far away from heat or fire. All harmful gas emitted during the charging process should be discharged outdoors. To prevent a short circuit, please use a well insulated tool to wire the batteries.

4. Preparation

4.1 Prepare a suitably long 7 gauge cable with a current intensity of around 4A/mm^2. If the cable is rather long, increase the wire gauge properly.

4.2 The installation site should have comparatively both higher average wind speed and weak turbulence, since these factors contribute to the generator's annual power output.

4.3 Prepare the foundation based on the drawings provided by your PowerMax+ distributor.

4.4 Check the components with the packing list. If you encounter any packaging discrepancies, contact your PowerMax+ reseller immediately.

5. Turbine Assembly

5.1 Tail Vane Assembly

Keeping the bracket upward, insert the tail vane into the end of the tail rod and align the 9×φ13 nozzle, finally fix it by 9 sets of M12×45（also nut, flat washer and flexible washer). **(**See Fig 3)

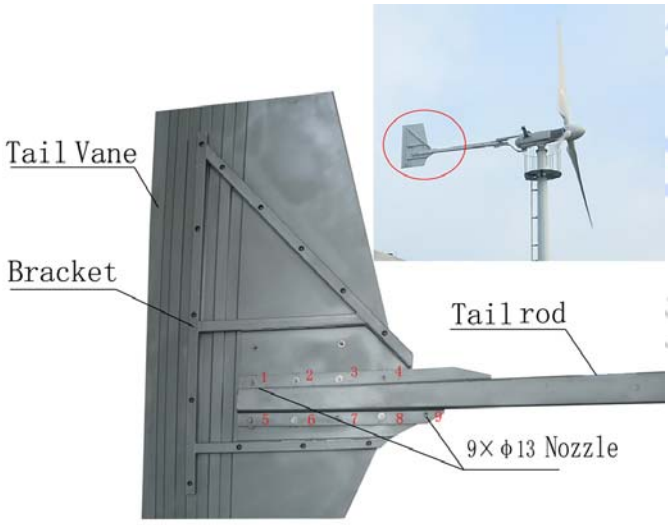


Fig 3

5.2 Tail Beam Assembly

Fix the rain cover with the 4—M10 nozzle of the tail beam by 4×M10×25 bolts, with a spring washer. Align the straight beam and bend beam with the tail rod and affix them by inserting 2 sets of M27×385 bolts with special washer. Put in the nut, but do not tighten. (See Fig 4)

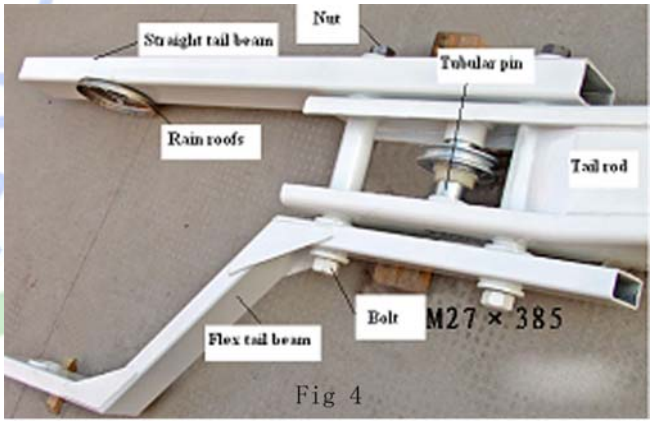
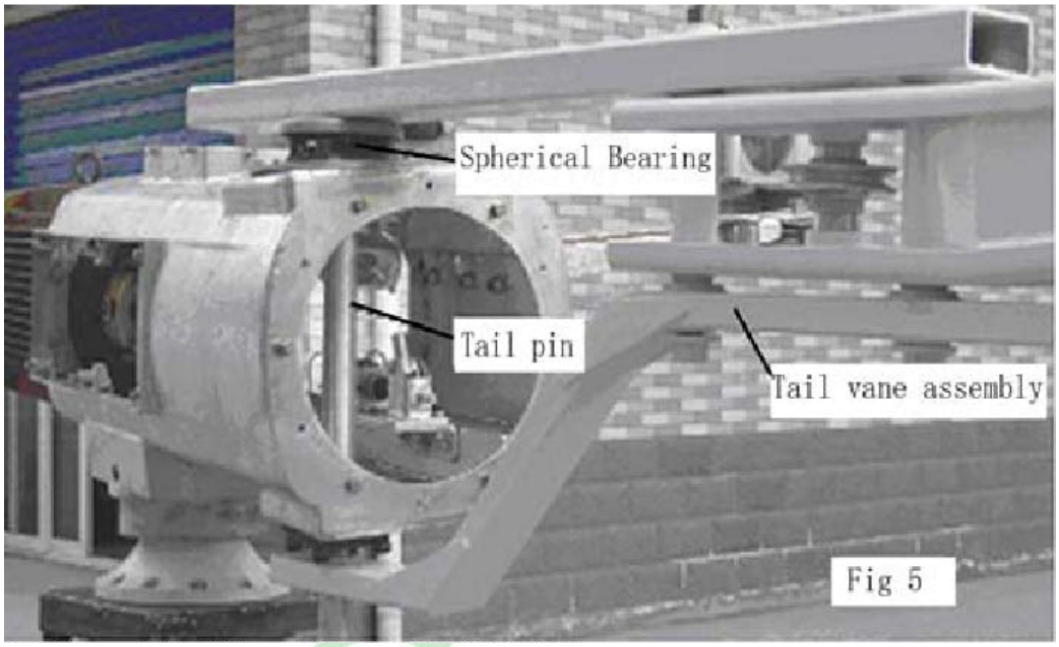


Fig 4

5.3 Tail Rudder Assembly

Hoist the tail assembly (combination of tail rod and tail board) and move it to the end part of the turbine, align the 2－φ50 nozzle of the tail assembly with the two nozzles of the sphere bearing of the nacelle ;insert the tail pin into the two nozzles to let the 2－φ18 nozzle on the base of the tail pin align with the 2－M16 bolt nozzle on the bend tail beam, tighten the M16×30 bolts with washer; fix the tail pin by 2 sets of round M45×1.5 nut and thrust washer; tighten the 2 sets of M27×385 bolt with stipulated torque, insert the open pin (See Fig 5).



5.4 Assembly of Nacelle's Winch:

Open the head cover of the nacelle and pass the steel rope with the adjustable knot through the jacket and PRR tube of the rope fixing disc. Pass the other side of the rope through the orientation pulley. Tie onto the tension hookup of the extended arm and fix it by a clamp. Close the top cover and screw shut. (Refer to the Fig 6).

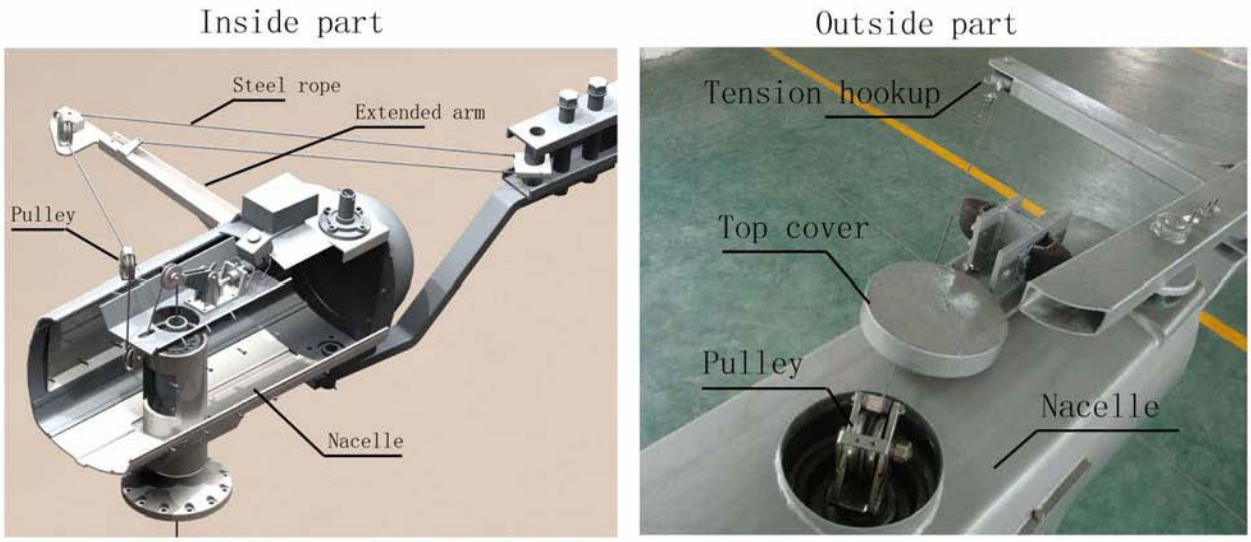
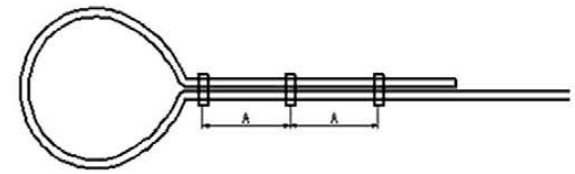


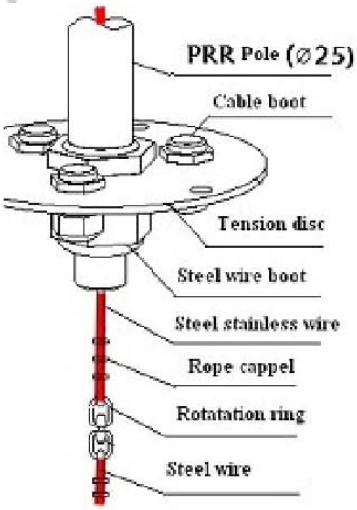
Fig 6

Note: Tighten the rope clamp as shown in Fig 7.



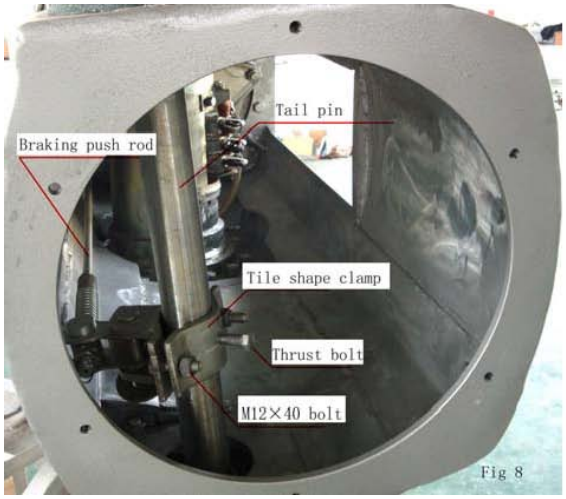
Diameter	Num.	1. Cable clamp can't be alternate arrange on the steel wire. 2. The distance A is 6-7 times of steel wire diameter. 3. The farthest away from lantern ring, the cable clamp can't be screw separately. The closest away from lantern ring, the cable clamp try it best to close to lantern ring, screw it correctly, it can't be damage the outer layer of steel wire.
<19	3	
<19-32	4	
<32-38	5	
<38-44	6	

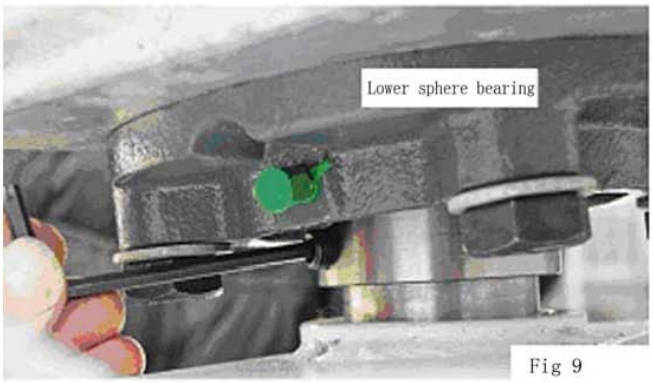
Fig 7



5.5 Braking Push Rod Assembly:

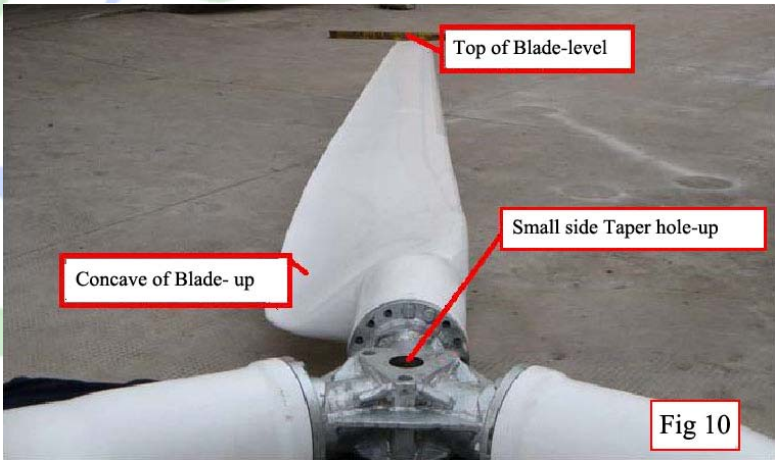
Connect the push rod with the tail pin by using two clamps and 2 sets of M12×40 bolts. The position of each clamp and push rod should be as shown in Fig 8. Also, as shown in Fig 8, each clamp should be locked by a thrust bolt. At Last, tighten the 4 inner hexagonal bolts M8, on the upper and lower sphere bearing. After completion, close and bolt the tail cover.





5.6 Blade Assembly

Place the blade hub onto a horizontal flat surface with the front side of the hub facing upward, to facilitate the tightening of bolts. The three heads of the blade hub have been marked by A, B and C respectively, which correspond to the three blades A, B and C. Your PowerMax+ rotor assembly has been factory-balanced and the marks on the blade hub must match those of the blades. Assemble the three blades onto the corresponding head of the blade hub based on the markings, (blade A should be attached to the head A, etc). Place the blade horizontally to align the blade flange and blade hub together firmly. With the blade's concave side facing upward, attach the first blade onto the hub by bolts (tighten the 4 bolts first, diagonally). Afterward, check the blade tip: if the tip position is horizontal tighten the remaining bolts. If not, dismantle the bolts and reassemble. Attach the other two blades onto the hub following the same procedure. (Refer to Fig 10)



5.7 Tower Assembly

There are 3 types of towers recommended for use with this PowerMax+ system: freestanding tower, tilt up tower and lattice tower. The tower length is adjustable, ranging from 15～30m combined of several sections; generally, each section will not exceed 9m for convenient delivery, for those towers longer than 18m, it is composed of upper, medium, and lower section. The upper and medium tower section will usually be connected by a plug, while the medium and lower section can be connected by a bolted flange.

5.7.1 Plug the upper and middle tower： Plug the upper tower with the medium tower and lay them onto the ground horizontally, push the two sections axially and combine them firmly by using 2 manual blocks pulling the chain and steel rope (the pulling force of each block should be 1～1.5t).

5.7.2 Connecting the middle and lower tower sections： Put the middle and lower tower sections together, and let the screw nozzle φ26 of the middle section flange align with those of lower section flange, insert the high strength bolt M24×50 with the flat washers, spring washers and nuts. Screw on the nuts diagonally and tighten them by a torque banner with a stipulated torque.

5.7.3 Assembling the working platform：lift the top end of the tower 1m above the ground and place a support bracket 1.2m from the tower head top. Assemble 5 brackets onto the tower; with each one being affixed by four M16×40 bolts. Do not tighten them immediately. Assemble the platform, which is comprised of 3 parts, by using 18 M12×30 bolts (including the nuts and spring washers). Connect the platform with the brackets by using 15 M12×30 bolts (including nuts and spring washers). Tighten the bolts of the bracket and platform with a set torque.

Note: the door of the platform should be in line with the maintenance ladder (Fig 11).

5.7.4 Assembling the maintenance ladder： the ladder is comprised of several sections whose standard unit length is 3m. The ladder of the 15m tower is comprised of 3×3m and 1×2.12m sections, the 3m section is attached by 3 M16×40 bolts (including nuts and spring washers); those should be arranged from the top to the bottom. The last section (1×2.12m) should be affixed by 2～4 M16×40 bolts (including nuts and spring washers).

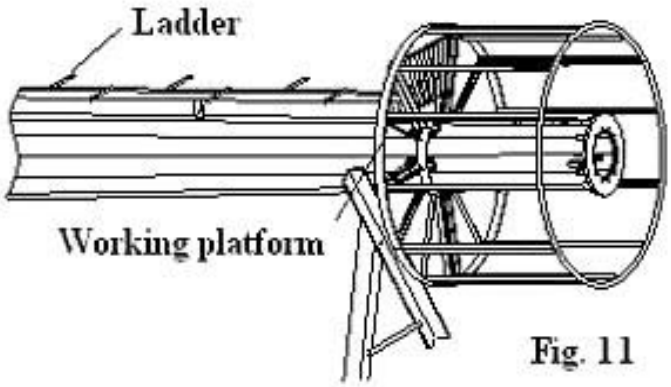


Fig. 11

5.8 Power Cable Connection

Open the tower top window, connect the three power cables with the cable terminal inside the tower. Feed the three cables （10～16mm² in cross section） from the tower foundation up to the cable terminal inside the top end of the tower, and attach them onto the inside inner wall of the tower by clasp to hold the weight of the cable.(as the fig 12 show)

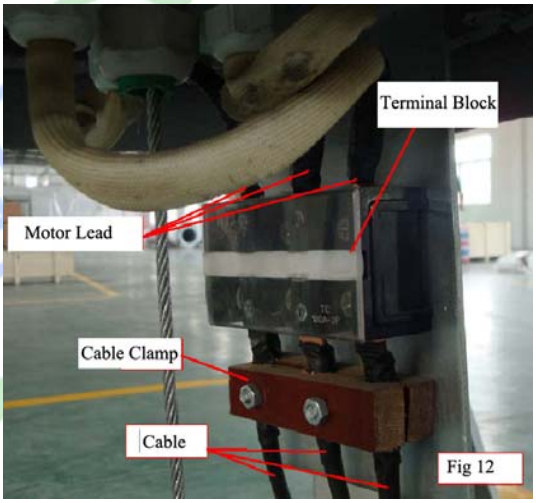


Fig 12

6 Machine Assembly and Installation

- Assembling the tower on the ground then lifting it up via crane, will take about 2 days for each tower.
- Manually stacking the tower segments piece-by-piece, will take 5-6 days for each tower.

6.1 Safety note for installation

DO NOT install the turbine or tower under extreme weather conditions, such as a thunderstorm, dense fog, sand storm, or hurricane. The installer should be familiar with the surrounding environment and must clear any nearby obstacles beforehand. Keep the installation site far enough from the electrified body. Only allow qualified technicians and professional installers to scale the erected tower.

6.2：Installation of turbine machine by crane

6.2.1 Installation site Clean up:

Clean up the thread of the feet bolt and the foundation platform. Meanwhile, prepare all the necessary nuts, flat washers and spring washers needed.

6.2.2 Lift the tower (fig 13):

Hoist the tower by a steel cable (over 15M) by passing the rope through the opening atop the tower, and put it onto the foundation platform which is ready.

Fig 13

6.2.3 Adjust the Perpendicularity of Tower:

Measure the perpendicularity of the tower by the plumb line (gravity line) method, then adjust the tower by adjusting the upper and lower nuts, finally tighten the nuts by torque spanner.

6.2.4 Main Machine Assembly

Before hoisting the turbine, fix the tail rudder with the position-fixing rubber block by a steel wire to prevent any possible damage caused by the unexpected swinging of the tail. Lift the turbine onto the tower top by crane, and then affix the turbine body to the tower top flange by bolts.
(See Figs 14 and 15)

6.2.5 Generator Output Cable Connection：

Open the maintenance window atop the tower and then affix the three output cables of the generator onto the cable fixing board inside the tower. **(See fig 12)**

6.2.6 Turbine Assembly： (Fig 16)

Short connect the three output cables of the generator at the bottom of the tower by electrical tape. Hoist the hub and blade assembly and position yourself at the front of the turbine body. Position the hub onto the generator shaft and put in the washer and the M56 nut. Tighten the nut with a torque of 1500～1700Nm and lock it by a M8×20 screw.

6.2.7 Nose cone assembly： (Fig 17)

Assemble the nose cone by the 12 sets of M12×40 bolts (with flat washers and spring washers)

6.2.8 The assembly of steel rope and braking system inside the tower： (Fig 18)

Affix the winch bracket onto the bottom of the tower by using 4 sets of M12*40 hex bolts, then affix the winch onto this bracket by M10*40 hex bolts. Finally assemble the stroll switch. Lengthen the φ6 steel rope based on the tower height, the length should follow the formula: tower height - 5m; spread stain-proof grease around the connecting part and steel rope inside the winch; connect one end of the rope onto the winch, pass the other end of the rope through the swing fork into the tower, and draw it out from the upper window of the tower, connecting with the detachable link chain beneath the vertical shaft. **(See fig 6)**

Fig 14

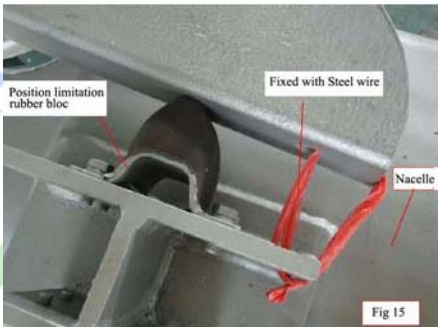


Fig 15

Fig 16

6.3. Brace Strut Lifting Method (when a crane is not available)

This method is suitable in those areas with poor traffic conditions (Fig 18).

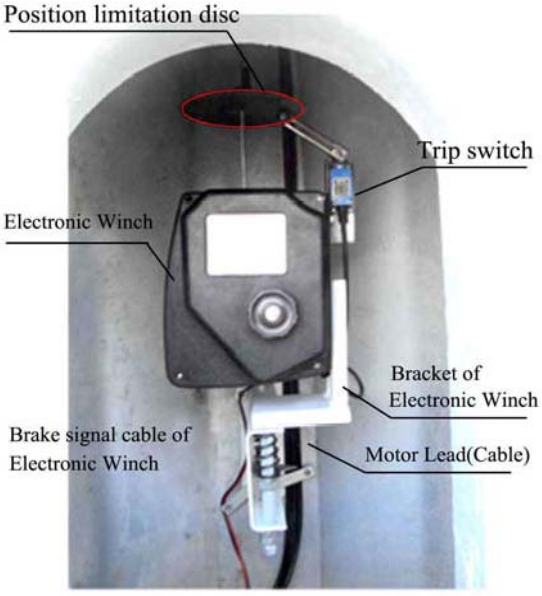


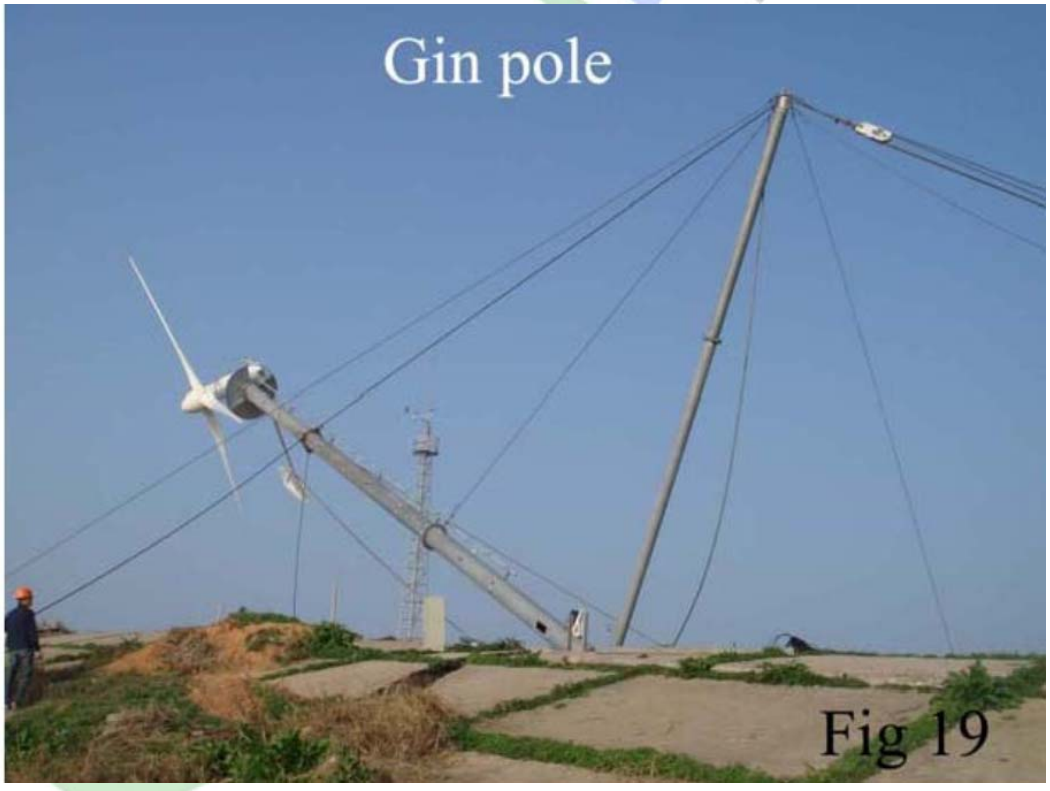
Fig 18

6.3.1 By using this method, the maximum wind speed during the installation of wind turbine needs to be no more than 4m/s；

6.3.2 The bare tower should be erected beforehand (with no turbine being assembled) to check the state of the equipment, tools and whether the crew is ready for installation.

1. Assemble the tower rod first, and fix it onto the tower base by a gemel, tie the right, left and rear guy wire onto their respective ground anchor, then tie a soft wire, 16mm (5 gauge) in cross section and 10m (35 feet) in length, onto the rear guy wire for manual operation. (The tower being assembled should be straight, if it is bending over, an adjustment is needed).
2. Lay down the holding rod toward the tower and attach it onto the tower base by a gemel, affix a saddle type iron plate onto the top of the holding rod, then tie four guy ropes onto the holding rod, with the left and right guy wire being connected with the left and right ground anchor. Affix the rear guy rope with the hanging ear of the tower rods, to let the two rods form an approximate 90°angle. The front guy rope of the tower should be connected with the steel rope of the hand winch.
3. Conduct a trial test of the winch before starting. Pass the steel rope of the winch through the ground anchor pulley, the movable block sets and fixed block sets, and then tie one head of the rope onto the base of the winch or ground anchor. Connect the pulley group with the front guy rope and tie this rope onto the top of the holding pole. While lifting the pole, adjust the right and left guy rope of the pole to keep the movement of the pole in the same plane. Keep an appropriate tightness on the guy rope (when a hoister is not available, other equipment, such as a truck, can be used). Conduct a trial test of the hoister. Pass the steel rope of the hoister through the ground anchor pulley. Fix pulley and tie one end of the rope onto the base of the hoister or foundation anchor. Connect the pulley with the front guy rope of the tower and fix it onto the end of holding bar. Lift the holding bar gradually by hand winch to the vertical position. During the lifting process, keep the holding bar within the same lifting plane by adjusting the right and left guy rope, keeping an appropriate tension on the guy rope (other equipment, such as truck, can be used in the absence of a winch).
4. Straighten the steel rope and pulley group. Pass the steel rope through the ground anchor pulley and tie it onto the winch horizontally. Start up the winch until the pull rope is taught, then pause and check all the fasteners and connecting points, as well as the tightness of the

left/right pull rope of holding rod and tower rod respectively. Start up the hoister again. While lifting, keep tightening the temporary front guide rope of the holding rod continuously by a hand winch and keep the holding pole and tower within the same plane. Watch and adjust the tightness of the left/right pull rope at all times. When the tower is at a 70° angle, stop the hoist. Check and make sure the pulley group has enough back setting allowance, so as to prevent the movable and fixed blocks from bumping each other. Check to ensure that the tightening mechanism of the left/right pulling rope is smooth. Adjust the brake of the bumper/holding soft rope. If there is no safety risk during lifting, start up the hoister to release the steel rope while holding the temporary front holding rope at the same time. Support the tower by a 2m wood bracket 4～5m from the tower top.



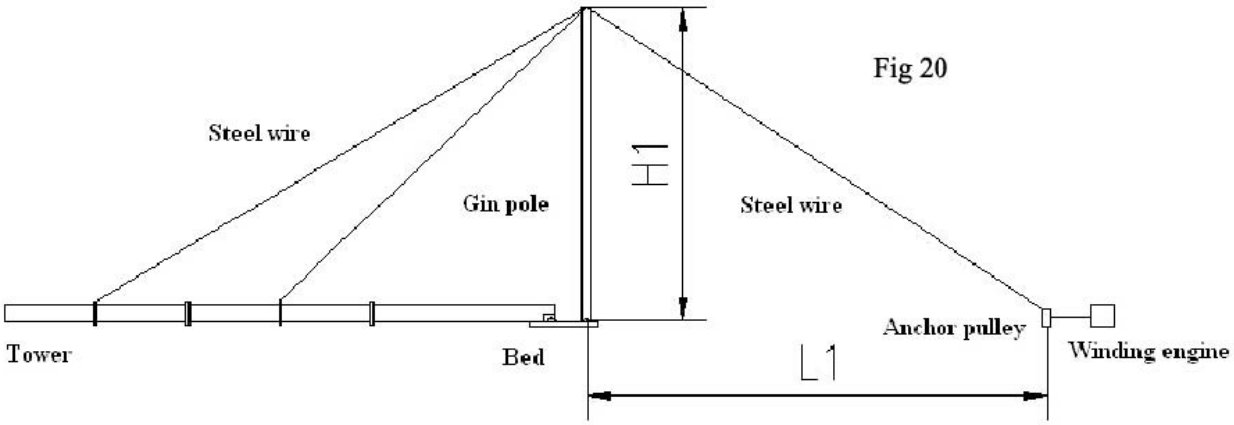


Fig 20

5. After a trial test of the pole, check the ground anchors, tie point of the steel rope and other equipment, then begin the final installation.
6. Assemble the nacelle, tail rudder, wind turbine and output cable, as well as the wire of the winch, and connect the vertical bearing with the tower top in accordance with sections 5.1, 5.2, 5.3 and 5.5.6 of this manual.

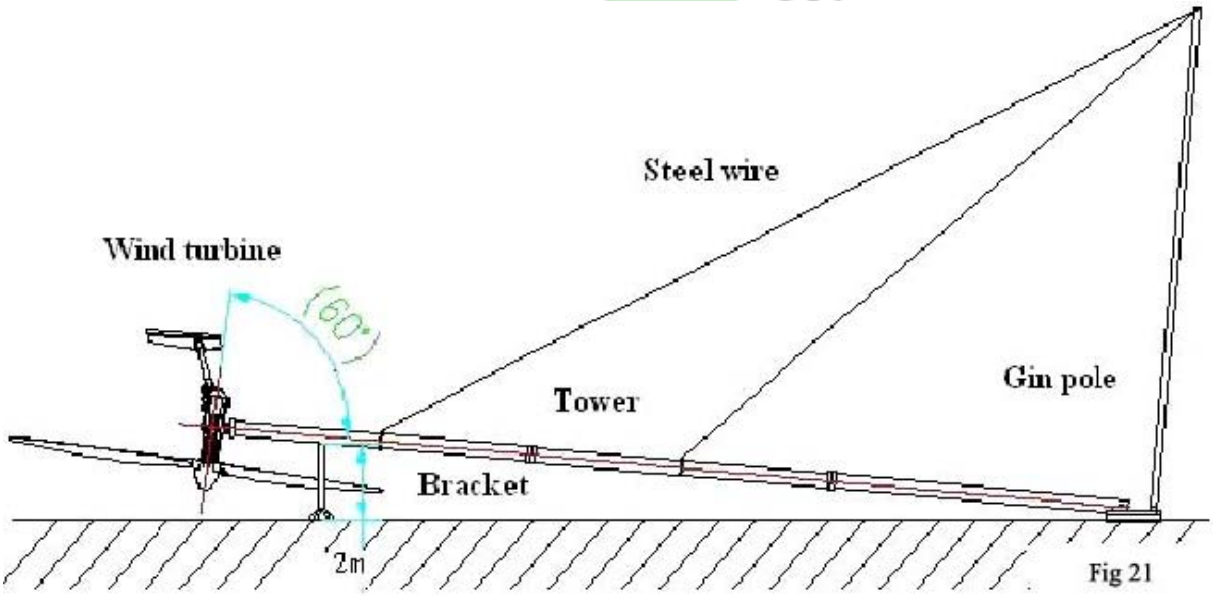


Fig 21

7. Short connect the three output cables of the turbine.
8. After the installation, adjust the weight position of the turbine main body to prevent the nacelle and tail rudder from turning while lifting.

6.3.3.2 Start up the winch to lift the turbine until the turbine leaves the bracket then pause it to see: if

there are any abnormalities in the ground anchors, connection of guy rope and holding rod, the flexible tower holding rope, temporary guide wire or any other conditions. After this safety check, start up the hoister again. During the lifting process, keep tightening the front guide rope of the holding rod, paying attention to the tightness of the right/left guide rope and holding rope. Lift the turbine slowly by inching the hoister until the tower is at a 70° angle.

6.3.3.3 Holding the front pulling rope of the tower, disconnect the pulley group from the front pull rope and then tie the front pull rope onto the front ground anchor. Remove the hoister, pulley group, holding rod and other lifting equipment. Adjust the perpendicularity of the tower against the ground by adjusting the four pull ropes. Tighten the pull rope properly and tighten all the fasteners with a stipulated torque. Lock the buckles on the four pull ropes and check that all the connections are firm. Spread anti-corrosion grease around all the connecting points.

A. Figure 21 shows the turbine assembled onto a tower that has yet to be lifted. The turbine is supported 2m above the ground by a bracket 4～5m from the tower top; after assembling the turbine, fold the tail and balance it. (The angle formed by the right side nacelle, nacelle axis line and tower should be around 60°).

B. Figure 22 shows the angle formed by the tower and ground has exceeded 70°. The hoister should be driven slowly. Hold the flexible rear holding rope at the same time.

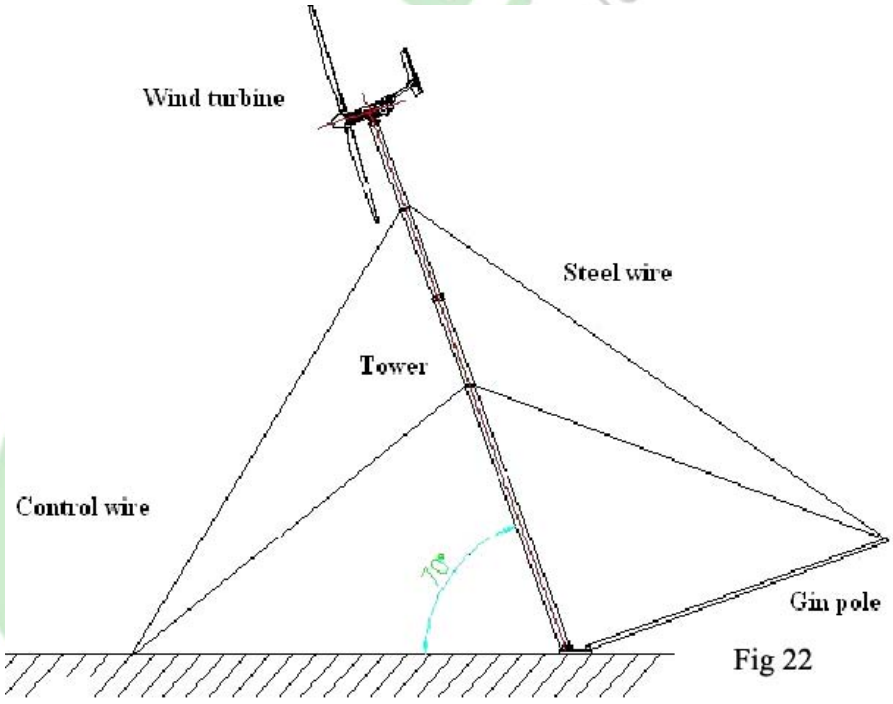


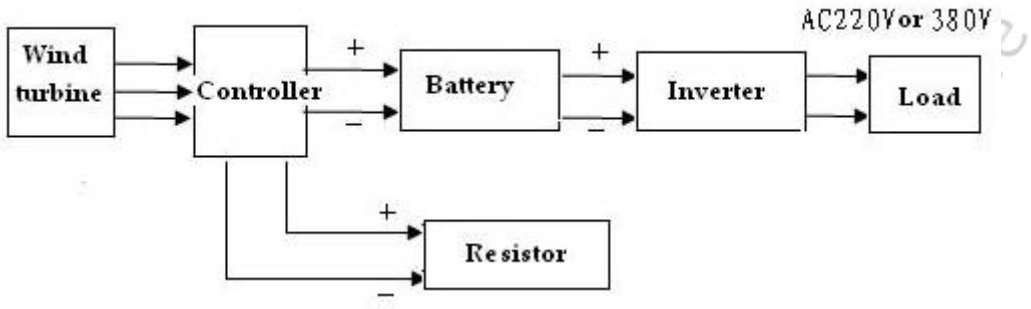
Fig 22

For the assembly of the steel rope inside the tower and brake mechanism, please refer to 6.2.8

7 Electric Connection

7.1 Off-Grid Type Wind Turbine System

7.1.1 System diagram (Diagram refer to Appendix 4)



7.1.2 System Brief

The wind power generator is comprised of equipment converting the kinetic energy of a moving air mass into electric power. It is widely used in wind-rich areas, where there is no access to a normal power supply. It is capable of powering the lighting, TV, telecommunication equipment, etc. through an off-grid inverter for the off-grid power supply application.

7.1.3 Combine the batteries into a "battery bank", with the "+" pole and "-" pole on both ends of the battery bank being marked by red and black colors, respectively. The battery line and guide cable should be 7 AWG. All the wire connecting parts should be fixed by a wire clip to guarantee smooth electricity transmission. Spread a layer of grease around the wire terminal and wire clip to protect them from corrosion. Connect the "+" pole of the batteries with the "+" pole output terminal of the breaker box (controller & Inverter). Connect the black battery wire ("-" pole) to the "-" pole output terminal of the electric box (Controller & Inverter). These connections must be firm to ensure good electric conductivity. Connect the three output cables of the generator with the three terminals of the electric box respectively. There are both DC and AC terminals on the electric box; Connect them based on the marks. For installation details, refer to the user manual of the controller and inverter.

7.1.4 Upon the completion of proper wiring, let the wind turbine charge the batteries first, when the batteries have been charged enough for the inverter, the inverter will be ready to supply power.

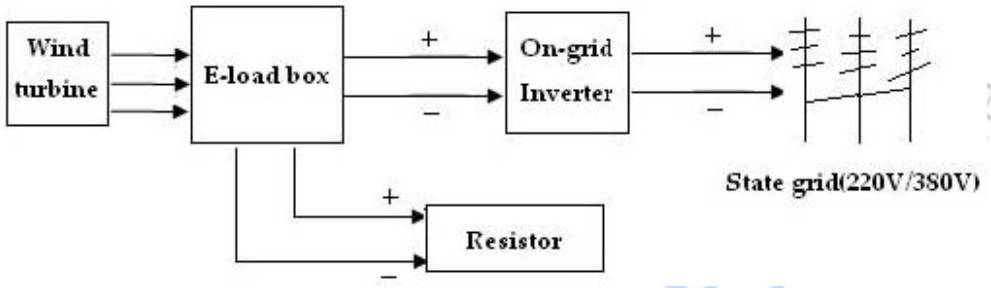
7.1.5 To guarantee their lifespan, the batteries must be recharged in a timely manner after their discharging. Please adjust the load based on your local wind condition and output power of the turbine to prevent the over-discharging and the subsequent damage of the batteries.

7.1.6 The voltage of the batteries should be equal to the wind turbine voltage; the DC output voltage of the inverter should also match the voltage of the wind turbine. The capacity of the inverter should be based on the peak power level of the load.

7.2 Grid-Tie Wind Turbine System

7.2.1 System diagram (the system diagram please refer to the fig 5)

7.2.2 System brief



The on-grid wind turbine system consists of the turbine body, on-grid controller, dump load resistance box, on-grid inverter and the affiliated electric system. Through a controller, the kinetic energy of the moving air mass will be converted into AC electric power by the wind turbine equipment. This unstable AC will be changed into DC, and then converted back into stable AC through an on-grid inverter. This AC power can either be fed back into the power grid or used by the load.

7.2.3 Connection of the on-grid wind turbine system
Wire the on-grid system based on the user manual of the controller, inverter and wind turbine. The cabling wire gauges should all be based on the actual controller and inverter selected.

7.2.4 The capacity of the dump load should be 2-3 times of the capacity of inverter.

⚠ WARNING

The wiring diagram in the appendices 4 and 5 of this user manual are only applicable for the controller and inverter from our company.

For the wiring of the on-grid wind turbine system (refer to appendix 6)

8 Operation

8.1 Checking before operation

8.1.1 Check all fasteners of the blades, rotor, and follow guiding cover, generator with nacelle, outside part of nacelle and tail vane, ensuring they are tight and reliable.

8.1.2 Check the blade assembly angle to make sure the folding and recovery of tail vane is correct.

- Check the tower rod connections and the connections between tower rod and foundation bolts, ensuring the stipulated tightening torque has been reached.
- Rotate the rotor and check that there is not blocking or friction on the generator or hydraulic braking device.

8.2 Checking output circuit line of generator

8.2.1 Open the right door of the nacelle, checking whether the connection between three output lines and electric brush are in good condition, tight and reliable.
8.2.2 Using universal electric meter, check the conducting performances between each end and slip ring to ensure they are conducting electricity.
8.2.3 Check the contact between the three output cables of the wind turbine and the connecting cable; see if the cable head has been fixed firmly. Eliminate any friction between the cable and steel rope.

8.3 Checking yawing mechanism and hydraulic braking device

8.3.1 Check the connection between the winch and steel rope.
8.3.2 Shut down the turbine machine and crank the winch by hand to see if there is any stagnation during the folding of tail vane.
8.3.3 Start the turbine; release the winch until the steel rope is loose. Check if the tail will recover its position quickly. Make sure the turbine can be moved.

8.4 Checking the compatibility of the electrical equipment and wind turbine system

Check that the electrical equipment is properly matched with that of the wind turbine system. Ensure that they meet all power supply requirements, that their technical state is good, and all line connections are correct.

8.5 Trial Operation

8.5.1 The wind turbine should be shut down before conducting any tests.
8.5.2 Check the wind-facing flexibility of the operating wind generator. When the wind speed is 4m/s, the wind turbine should rotate in response to the changing of wind direction.
8.5.3 When the wind speed is more than 4m/s, the blades should start spinning. Because of the friction between braking disk and braking slice, when new turbines are first put into operation, it is

normal to have a higher start-up speed. After a short time running, the friction phenomena will disappear automatically. During the operation period the wind turbine should spin steadily and without obvious vibration. Check that the three output lines of the generator and their voltage are equal. When the wind speed is more than the rated wind speed, the rotor should have an obvious yawing action and the peak value of power output is not more than 1.8 times the rated power in strong wind conditions. Only after passing the above examination to ensure that all technical conditions are satisfied, can the wind turbine system be put into daily operation.

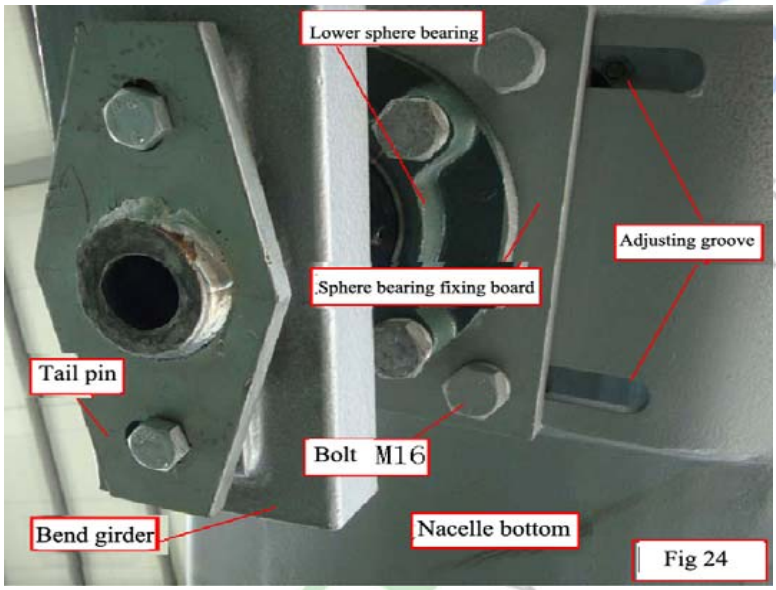


Fig 24

1. Upon the completing the wind turbine assembly, operate the turbine system in accordance with the user manual of the controller and inverter. Monitor and make sure the controller, battery bank and inverter will work normally. The inverter will power the load or feed the grid normally.
2. The turbine system may be put into service after the aforementioned check.

ADVICE

It is normal for any new wind turbine system to require a slightly higher start up wind speed.

8.6 Normal operation

1. During the trial operation, make sure all systematic parts are in the normal status and have no other fault.
2. This system must be operated by specially trained personnel.
3. All operation must obey strict regulations.

8.7 Normal shut down

8.7.1 Automatic shut down: The turbine controller will keep monitoring the output voltage and current of the turbine. If any of the parameters exceed the set level, the system will automatically shut down for protection.

8.7.2 Manual shut down: If the turbine needs to be shut down manually, whether for repair, maintenance or approaching storm, simply trigger the manual dump load switch on the controller to increase the load of the wind turbine and slow down its rotation speed. Then press the manual braking button on the controller or operate the winch by hand directly to let the turbine fold its tail and shut down.

8.7.3 When shutting down the turbine for a long period, the controller and inverter should be switched off to prevent the over-consumption of electricity stored inside the batteries.

8.7.4 Recovery: The turbine should be restarted by manual winch after it has been either manually or automatically shut down.

⚠ WARNING Please switch off the inverter before the controller. For the switch-on operation, follow the same procedure.

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9. Maintenance

9.1 Routine maintenance

9.1.1 Check whether the wind generator is operating smoothly. If any strange vibrations or noises are detected, stop the wind generator until the problems have been eliminated.
9.1.2 When the wind speed is more than rated wind speed, ensure that the yawing action of the wind generator is easy and smooth.
9.1.3 Make sure that the 3-phase output is balanced, the power output is in normal condition, and that the "flow diversion or discharging" is kept unblocked and reliable.
9.1.4 Check that the batteries are being sufficiently charged.
9.1.5 Check that the technical condition of the electric winch is good.

9.2 Maintenance after first 1,000 hours

9.2.1 Check all nuts and bolts, and tighten them in accordance with the stipulated torque.
Checking emphasis is as follows:

- Tower foundation/base bolts
- Linkup flange bolts of tower rods
- Bolts between the vertical shaft flange and the tower top
- Rotor hub nuts
- Blade bolts
- Air flow diversion cover bolts
- Bolts between the generator and nacelle
- Round nut on the vertical shaft bearing
- Main tail pin bolts

9.2.2 Check welding positions of the tower rod to ensure that there are no cracks of flaws.
Checking emphasis is as follows:

- root part
- linkup flanges
- tower top flange
- rotor hub
- tail beams

9.2.3 Check hand-turning and winch-driving tail folding action (tail fold to 45°～60°) to see whether there are any blocking phenomena. Check whether the tail vane can retract easily after releasing. If there are any unusual conditions, please ascertain the reasons and eliminate the breakdowns.
9.2.4 Check whether the blade bolts are loose or missed. Check whether the bolts to the air flow diversion cover are loose or missing. Tighten if necessary.
9.2.5 Check the output circuit lines of the generator.

9.2.5.1 Check the three output lines of the generator to see whether they are attached firmly in the nacelle.
9.2.5.2 Check the connection between the three output lines and electric brushes, ensuring they are firmly fixed and that the conducting contact is in good condition.
9.2.5.3 Check the contact between the 6 brushes and electricity conveying slide ring to see if there are any bad contacts, over heating or burning phenomena.
9.2.5.4 Check the three phase output voltages to see whether they are balanced.

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9.3 Checking after strong wind

After suffering the first big wind (＞25m/s), re-check 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.2.5.

9.4 Routine checking & maintenance after every 3,000h operation

9.4.1 Repeat every check and maintenance process detailed in section 9.2.
9.4.2 Check the technical conditions of the rotor.
9.4.2.1 Checking the contour of the blades, with emphasis on the tips and front edges, to see whether there are any cracks or damage.
9.4.2.2 Check the blades to detect any changes which can result in unbalanced deformation, translocation or change of setting angle.
9.4.3 Clean the electricity conveying slip ring and electric brushes, polishing the conducting contact face. Any worn electric brush should be replaced by a new one. The contact area between the brush and slip ring should reach 95% or more.

9.5 Maintenance

9.5.1 Check the fasteners and graphite brushes regularly.

9.5.2 Check the steel ropes regularly and replace if necessary.

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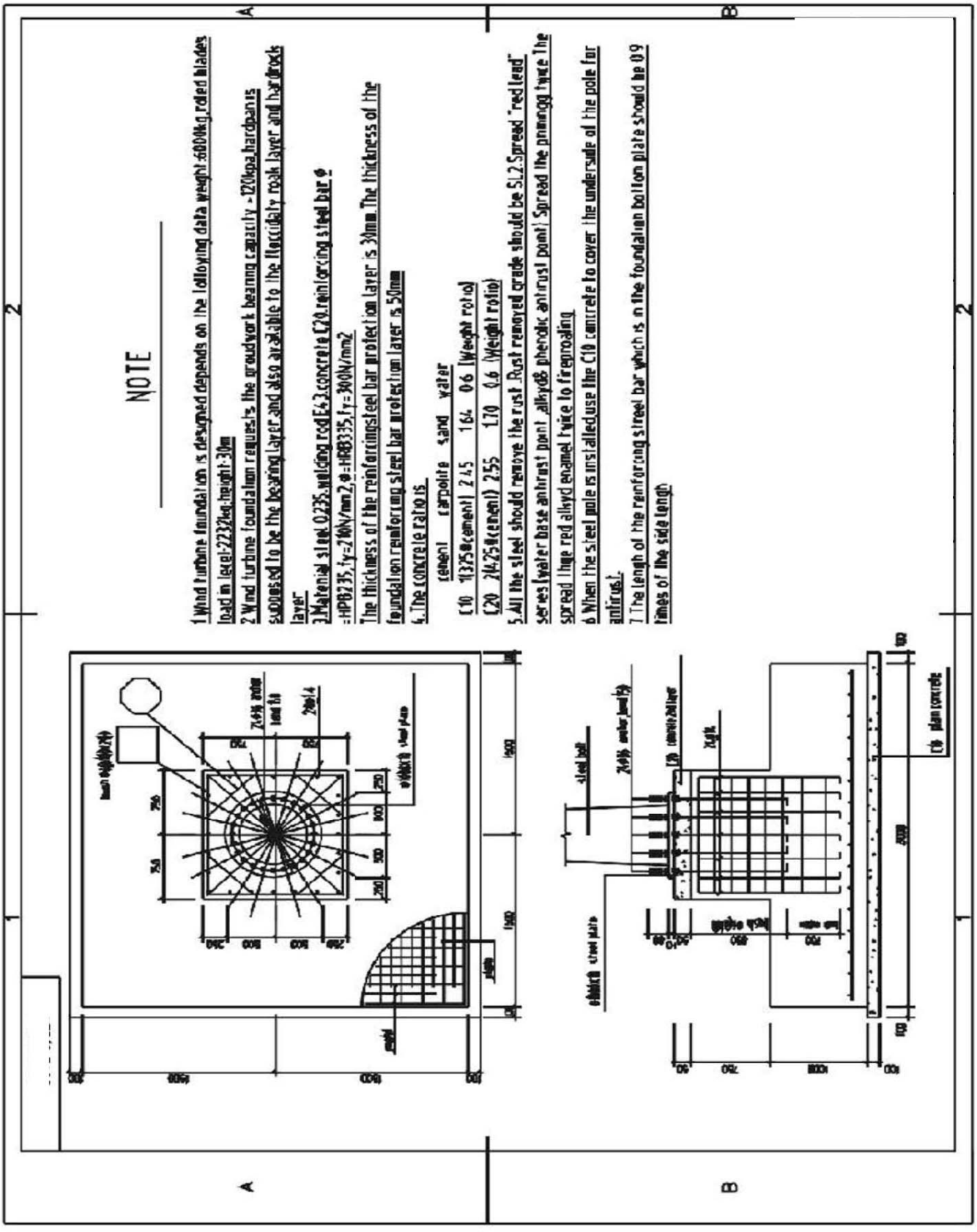
10. Troubleshooting

Problem	Possible Reasons	Possible Solutions
Wind speed is bigger than 4m/s, but the rotor does not rotate	1. Setting angle of blades is too small 2. Rotor has not passed a balance test, or one blade is overweight and sagging 3. Starting resistance torque of generator is bigger 4. Short cut occurred in the output circuit of generator, or load has been accepted in advance 5. Braking mechanism is blocked and the tower rod is not in vertical state or the bearing of vertical shaft is too tight and making the rotor not face the wind direction	1. Adjusting according to the design 2. Balance blades in accordance with technical requirements 3. Check the resistance torque of generator, ascertaining the reason and eliminating the problem 4. Ascertain the short cutting positions; Postponing the acceptance of load 5. Ascertain the friction positions and eliminate the friction phenomena 6. Adjust the tower rod to its vertical state; if the bearing of vertical shaft is too tight, it should be adjusted to a rather loose state
Direction adjustment (facing the wind) is not nimble	1. Bearing rotating resistance of vertical shaft is bigger 2. Tail vane does not retract	1. Adjust the clearance of bearing or replace the bearing 2. Ascertain the reason and restore the tail vane to its normal position.
The rotating speed of rotor is obviously rather lower	1. Setting angle of blades is too big 2. Resistance of generator bearing is bigger, or the bearing is damaged 3.There is a shortcut in the output circuit of generator 4. Load is not matched 5.The friction of the braking mechanism has not been released	1. Adjust in accordance with the design requirement 2. Check and replace it with a new one 3. Eliminate the shortcut 4. Adjust working voltage, load adding work point 5. Ascertain the reasons of the friction & blocking, and then eliminate the problem.
Vibration of wind turbine	1.The blade bolts are loose 2.Water entering the blade, freezing, rotor lost balance 3. There is damage to blade, causing power and gravity lost balance 4. Generator, power output circuit (including electricity conveying slide ring) is losing electricity current and phase. 5. The vertical shaft bearing of nacelle is loose or damaged. 6. The bearing of the tail vane is loose or damaged. 7. Braking mechanism is blocked intermittently. 8. Wind turbine is rotating in high speed at yawing state. 9. Wind turbine is rotating in over-speed state	1. Replace with new bolts and tighten them in accordance with stipulated torque. 2. Eliminate accumulated water or ice, adjusting the rotor to balanced condition 3. Repair the blades and rebalance 4. Check whether the three phase output is balanced; check wire connecters of breaker box to output wires of generator. 5. Tighten in accordance with the requirement or replacing it with a new one. 6. Ascertain the friction or blocking positions; repair and eliminate. 7. Check branch braking pump, braking disk and braking slices 8. Check braking device and the size of yawing angle 9. Check the load of controlling box (including shunt), adjust and track, increase the load properly

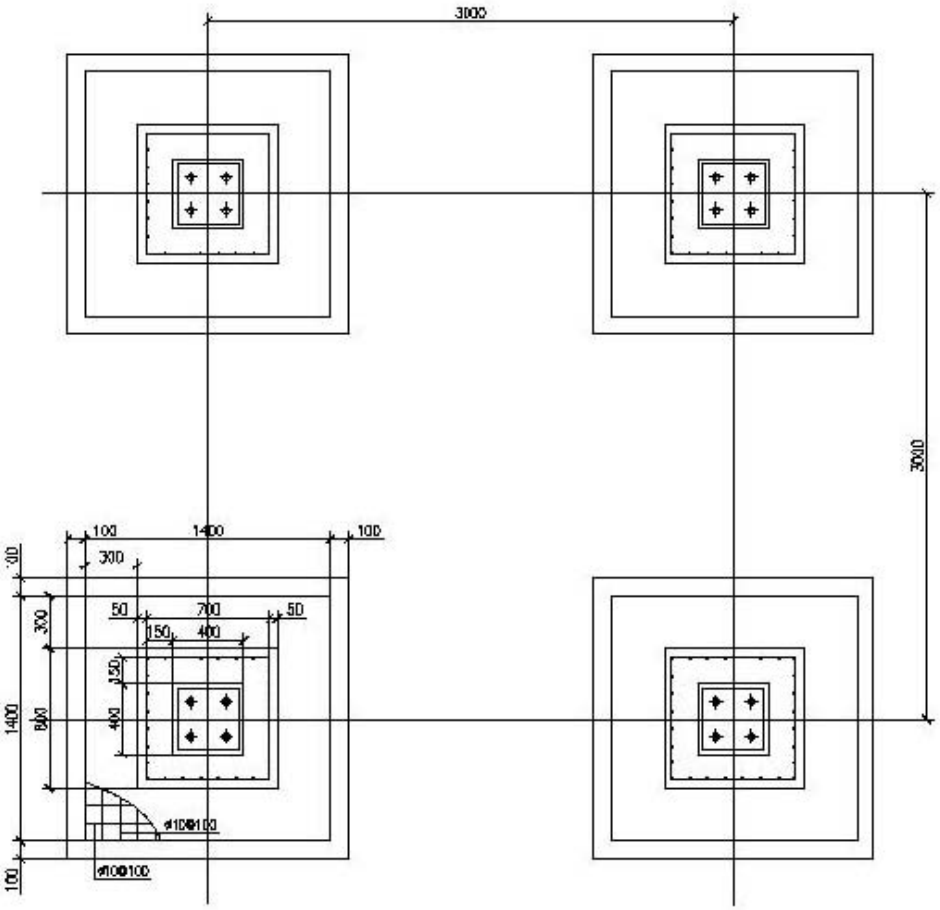
Unusual noise	**1. The rotor bolts are loose** **2. The three-phase power output is not balance** **3. Generator bearing is loose or damaged** **4. The bearing of vertical shaft is loose** **5. There is friction in braking mechanism** **6. Parts inside the nacelle are loose** **7. The tail vane bearing is loose** **1.The fixing parts of framework and tail vane are lose** **2.Causing resonance owing to over speed rotating of the rotor**	**1. Find the loose part, then tighten or replace with a new one** **2. Check generator, control circuit and load; Ascertain the reason of stoppage and eliminate it.** **3. Ascertaining the damaged bearing and replaced it by a new one** **4. Adjusting the clearance** **5. Checking and repairing the mechanism, so as to eliminate the frictions** **6. Tightening them to eliminating the loosen phenomena** **7. Replace new parts** **1. Tighten them and eliminating the problem** **2. Stop the wind turbine, ascertain the reason; After eliminating the problem, start the wind turbine again**
Rotating speed of the rotor is too high, even exceeding the limited rotating speed	**1. Operating without any load** **2. Load is too small** **3. Yawing action of the rotor is difficult, adjusting & controlling action is slow** **4. The tower rod is not vertical to horizontal plane, so as to effect the normal action of yawing mechanism** **5.Yawing angle is not enough** **6.The tail vane bearing is blocked and causing the tail vane to not fold freely**	**1. Stop the wind turbine, eliminate the problem** **2. Adjust the matching relationship between output power of wind turbine and load** **3. Adjust the inclination angle to suit the local wind conditions** **4. Adjust the vertical degree in accordance with the requirement of specification** **5. Adjust tail folding angle to 75°～80°** **6. Check & repair to eliminate the problem; or replace it with a new bearing**
There are breakdowns in electricity supply circuit, the wind turbine cannot be stopped	**1. There are breakdowns in controller, it can not shunt and unload when wind turbine is over powering or over speeding** **2. Energy consumption capacity of the shunt—unload device is not sufficient** **3.Yawing mechanism, braking system are out of order**	**1.Eliminate the breakdowns of the controller** **2.Increase the energy consumption capacity properly** **3.Ascertain the reasons, repair and eliminate the problem, braking torque must bigger than 350Nm**

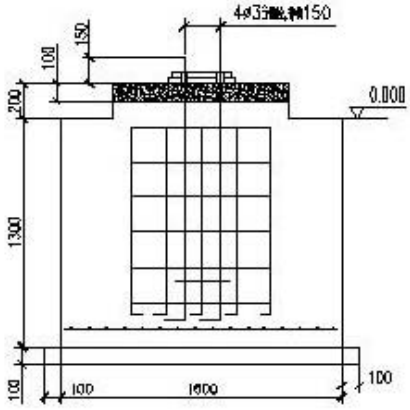
Appendix 1 15m freestanding tower foundation


NOTE
1.Wind turbine foundation is designed depends on the following data weight:6800kg,rated blades load in level:2232kg,hub height:30m
2.Wind turbine foundation requests the groudwork bearing capacity ≥120kpa,hardpan is supposed to be the bearing layer and also available to the flaccidity rock layer and hardrock layer
3.Material steel:Q235,welding rod:E43,concrete:C20,reinforcing steel bar Φ =HPB235,fy=210N/mm2,Φ=HRB335,fy=300N/mm2
The thickness of the reinforcingsteel bar protection layer is 30mm.The thickness of the foundation reinforcing steel bar protection layer is 50mm
4.The concrete ratio is.
cement carpolite sand water
C10 1(325kg cement) 2.45 1.64 0.6 (Weight ratio)
C20 2(425kg cement) 2.55 1.70 0.6 (Weight ratio)
5.All the steel should remove the rust .Rust removed grade should be St2.Spread "red lead" series lwater base anhrust paint ,alkyd8 phenolic anhrust paint/ Spread the primmgg twice The spread lhge red alkyd enamel twice to fireproofing
6.When the steel pole is installed,use the C10 concrete to cover the underside of the pole for antirust.
7.The length of the reinforcing streel bar which is in the foundation bottom plate should be 0.9 times of the side length
A
B
1
2

Appendix 2

15m lattice tower foundation drawing (the minimum tolerance pressure of the soil should be over 120*103Pa.





Structure Specification

1. The material of this project: Steel Q235; Weld rod E43; Concrete C20.

Steel bar ⌀HPB235, fy=210N/mm² ; HRB335, fy=300N/mm² .

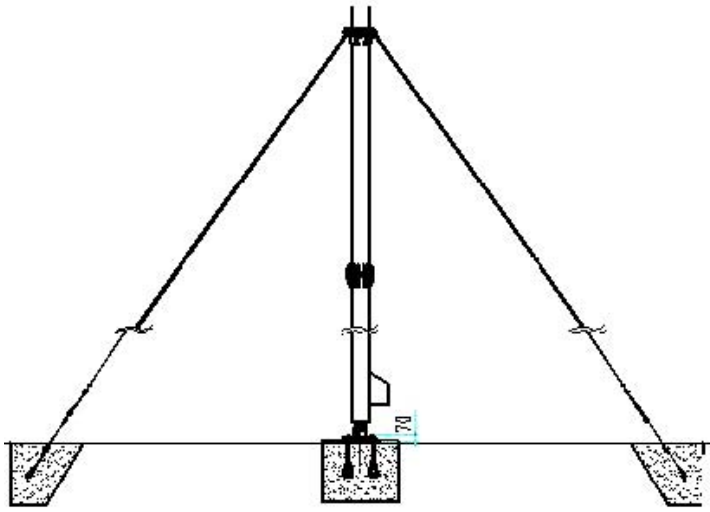
The thickness of protection layer of steel bar is 30mm, the thickness of protection layer of base steel bar is 50mm.

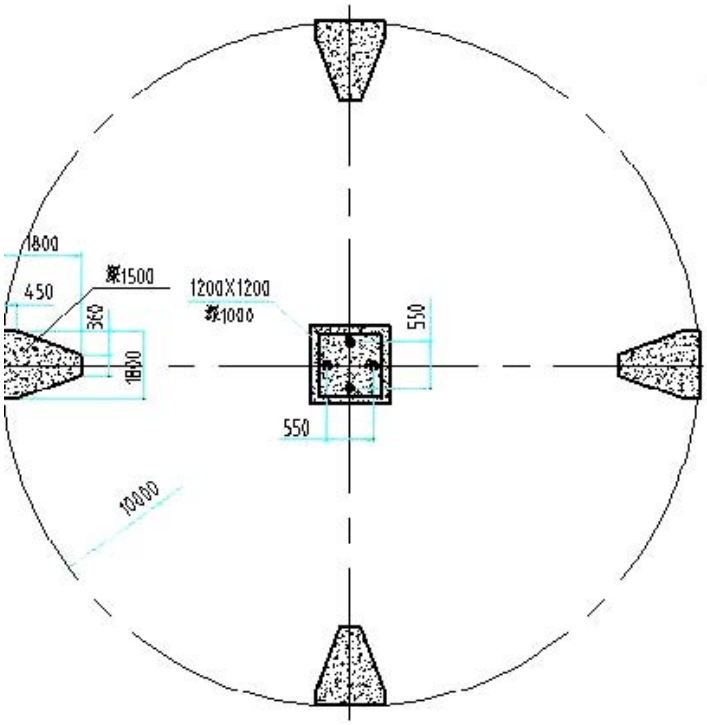
2. All steel materials should be derusting, the derusting grade is 5+2, painting the lead red.

3. After installed the staker, concreting by C10.

Appendix 3

15m guyed tower foundation drawing (the minimum tolerance pressure of the soil should be over $120*10^3$Pa)





Structure Specification

1. The designing of the turbine foundation is based on the following data: Weight of equipment:4500kg,height of equipment:16m.
2. The bearing capacity of the soil of the turbine foundation should be over 120KPa.
3. The soil layer of the turbine foundation is a hypothesis bearing layer(soft rock or solid rock Bearing layer is applicable as well). The following material will be needed in this project:steel rod :Q235;welding rod:E43,concrete:C20.

   Φ为HPB235 ,fy=210N/mm² Φ为HRB335 ,fy=300N/mm²
4. The thickness of the steel rod protection layer: 30mm, the thickness of the foundation steel rod protection layer:50mm.
5. Mixture ratio of the concrete is cement:crashed stone : sand : water

   C20 1\425# Concrete) 2.55 1.7 0.6 (By weight)
6. All the steel used in this project should be derusted,the grade of derusting is :St2.
7. Spread two layers of oil based anti rusting painting or phenolic painting as the priming paint,then spread two layers of alkyd resin enamel for Fireproofing.
8. After putting the steel rod,seal the rod feet by concrete for rustproofing. The length of steel bar stress should be 0.9 times of side length of foundation,and arrange the steel bar into a staggered pillar layout. If there is any inconformity,please refer to our technician and designer.

Appendix 4

Packing list

Component		Quantity	Package
Blade		3	Wooden box
Tail vane and tail rod		1	Soft package
Nacelle and motor		1	Wooden box
Blade hub		1	Wooden box
Nose cone, rear cover, tail plate		1	Wooden box
Controller/inverter(optional)		1	Wooden box
Battery bank(optional)		42 (variable)	Wooden box
Accessory	Electric brush	6×1	For free
	Stainless steel wireφ6	6m	For free
	Wire clamp M6	1	For free
	Flexible ringφ10	1	For free
	Oil seal φ110×φ80×12	1	For free
	Braking	2×1	For free
	Steel wire sheath	4	For free
	Vertical shaft M16×70	12	for free
	Blade bolts M16×55	16	For free
Tool	Tool box	1	1 for each patch
Reference	User manual	1	
	User manual for inverter	1	
	Certificate	1	

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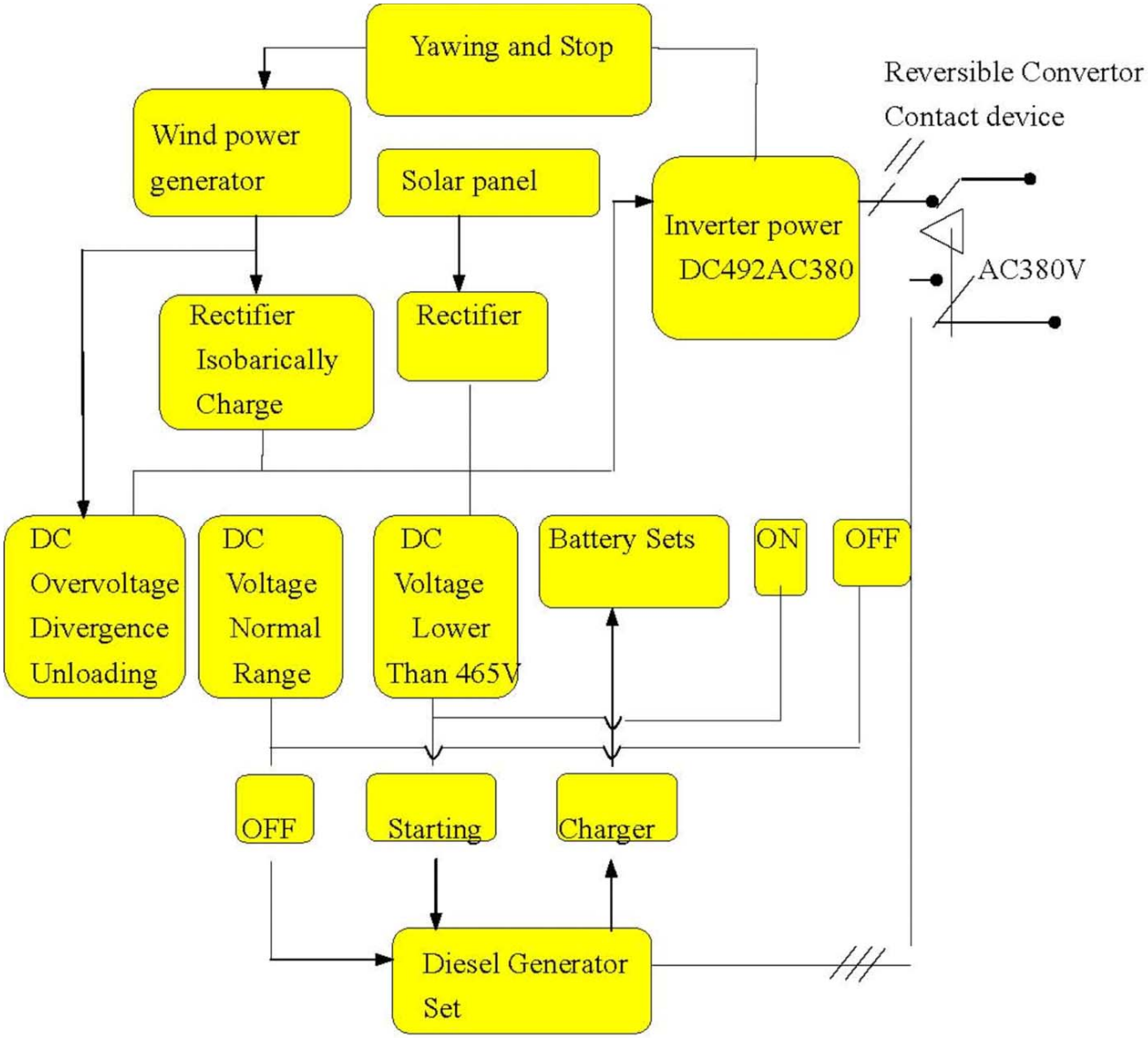
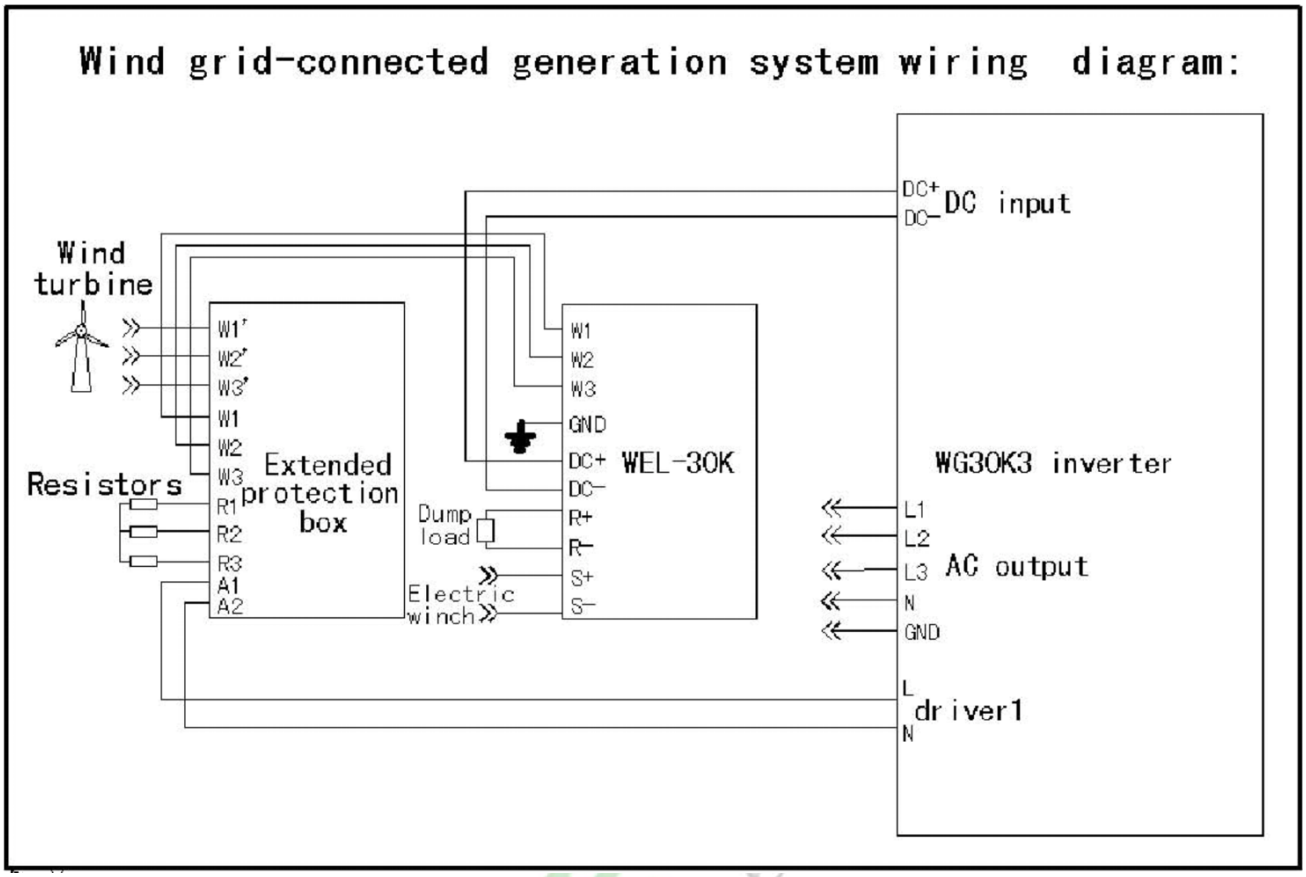
Appendix 5 Battery gathering Energy, Wind, PV, Diesel hybrid power supply way.



Appendix 6 Power Application AC380V/AC220V



Appendix 7 Bolts Tightness Table (Nm)

Performance Grade	**35**、**45** HB101 ~ 207 5.6 (σs = 300MPa)	**16MnVB**、**45** HB285 ~ 321 8.8 (σs = 640MPa)	**40Cr**、**40MnB** HRC35 ~ 40 10.9 (σs = 800MPa)
M6	4 ~ 6.5	6 ~ 12	
M8	8 ~ 15	16 ~ 30	
M10	18 ~ 30	36 ~ 63	
M12	30 ~ 47	70 ~ 110	90 ~ 135
M16	85 ~ 127	180 ~ 210	220 ~ 300
M20	167 ~ 250	350 ~ 410	440 ~ 520
M24	300 ~ 460	580 ~ 650	820 ~ 900
M27	450 ~ 600	775 ~ 880	1085 ~ 1198
M30	510 ~ 680	870 ~ 985	1220 ~ 1350
M36	660 ~ 745	1250 ~ 1420	1760 ~ 1940
M42		1705 ~ 1930	2390 ~ 2640
M45		1820 ~ 2165	2670 ~ 2965
M48		2230 ~ 2520	3125 ~ 3450
M56		3035 ~ 3430	4250 ~ 4695